The specimens of limestone analyzed by Dr. Ehrenberg were brought from Gyzeh, on the left bank of the Nile, and from Mokattam, near Cairo, on the right bank. It was compact, the small Foraminifera serving as cementing-matter among the Nummulites of which the rock is mainly composed.

The figured Foraminifera of plate xxiii. bear evidence, in the truthful engraving of their somewhat rough, partly obscured, and occasionally broken condition, to their having been closely cemented and much mineralized by carbonate of lime in their fossil matrix.

[To be continued.]

XXIV.—*On some Recent Researches in Vegetable Physiology.* By M. Marc Micheli.

[Continued from p. 155, and concluded.]

II.

The study of the phenomena of which the interior of cells is exclusively the theatre, of the transformations which are manifested there, and of the substances which they contain has also produced some works which deserve notice, and in the first place the researches of M. Schrœder * upon the "spring period of the maple." The author has paid attention to all the successive phases presented by the development of the vegetation, from the ascent of the sap to the moment when the expanded leaves begin to decompose carbonic acid. This is one of those complete and conscientious works which, even when they do not contain any very novel results, are nevertheless very useful to read and consult; but it is difficult to give a clear notion of them in a few words.

A glance at the course followed by M. Schrœder will show the great number of facts which group themselves within a framework such as he has adopted.

The first part is entirely devoted to the study of the sap, its ascent, and its composition. The maple, under the latitude of Breslau, "*weeps*" for about a month; the sap rises gradually to a certain level, whence it descends again by degrees, in proportion as the development advances. Holes pierced in the trunk at different heights enabled this sap to be collected daily; and very numerous analyses keep us informed of the smallest variations in its composition. It always contains sugar, a transitory product of the transformation of the starch accumulated in the tissues during the pre-

* "Frühjahrsperiode des Ahorns," Pringsheim's Jahrb. vii. p. 261.

ceding summer, and destined to become retransformed when it reaches the buds. The proportion, faithfully represented by a great number of curves, is but slight at the first awakening of vegetation; it increases gradually up to a certain maximum, in proportion as the vital phenomena acquire more intensity; and, finally, it diminishes when the young organs, approaching the term of their development, are on the verge of sufficing for themselves. These facts are therefore perfectly in accordance with such a theory of growth as has been established by the researches of modern observers.

The albumen and the mineral salts are successively studied from the same point of view; and their dissemination in the sap at different heights at the same moment, and at different periods, is exactly governed by the different phases of development.

The second part is devoted to the microscopic examination of the bud. The different substances which are called upon to assist in the development of the young leaf are traced by means of reagents from cell to cell. Two, especially, give origin to detailed observations, namely starch and tannin.

The dissemination of the former in the different tissues, its transportation through the starchy layers of the fibro-vascular bundles, its disappearance towards the point of vegetation, at the surface of which it speedily reappears as cellulose—all these different phases are taken up step by step; and here, again, we find a confirmation of all that theory led us to foresee.

As to tannin, it is developed in all the cells of the bud; and when once it has made its appearance, it persists there without appreciable change. Its function has greatly embarrassed M. Schrœder, as he was unable to recognize in it any of the characters of an excrementitial product, properly so called. The fact that it is constantly to be found in the youngest tissues (in which life is most intense) seems to indicate that it is a sort of final product, charged with a still unknown office in the life of the cell. If the true chemical nature of this substance were better known, the solution of the problem would perhaps become easier.

Certain authors have thought that the course of vegetation in the Agarics induced a marked exhalation of gaseous ammonia at their surface. M. Sachs mentions the fact in his 'Treatise on Physiology,' but without absolutely affirming it. M. Borscow * has undertaken a series of experiments, upon which he

* Mélanges Biologiques tirés du Bull. de l'Acad. Imp. des Sci. de St.-Pétersb. tome vii. p. 121.

relies to affirm positively the existence of this phenomenon. According to him, the production of gaseous ammonia is a general fact in the family of the Agarics; the quantity of gas exhaled is in proportion to the vital activity of the plant, but has nothing to do with its weight. It is equally without any relation to the production of carbonic acid as a result of respiration.

But quite recently MM. Wolff and Zimmermann* have objected to these conclusions. In all their experiments they were only once able to recognize some traces of ammonia, and the Agaric was not under conditions so normal as the others. These two authors, therefore, believe that in the Agarics, as in other plants, ammonia is a product of the decomposition of the tissues, but a product which begins to make its appearance immediately the vital functions of the organism are slackened.

Inuline, a substance of the starch-group, which is met with in a considerable number of plants, has been made by M. Prantl† the subject of a memoir crowned by the University of Munich.

The results obtained by the author of this memoir are in all essential features in accordance with what MM. Nägeli and Sachs have said of inuline. M. Prantl describes this substance as a hydrate of carbon, which differs from starch, cellulose, and lichenine in never taking on an organic form. Its fixity sufficiently differentiates it from dextrine. It seems to approach most nearly to cane-sugar.

Inuline is constantly found in plants in the form of a solution of 1 part of inuline to 7 of water. As in artificial solutions 0·01 gramme of inuline saturates 100 cub. centims. of water, we may suppose that when dissolving in the plant it undergoes transformation. It never appears except in subterranean organs.

This substance is pretty frequently produced in plants of different families, but especially in the Compositæ. The dahlia and certain *Helianthi* contain considerable quantities of it.

From a physiological point of view, inuline plays exactly the part of one of those nutritive principles which are put in reserve, such as starch, sugar, oils, &c. As we have just said, it exists exclusively in subterranean organs, tubers or rhizomes. At the moment of growth it is transformed into cane-sugar towards the collar of the root, then mounts into the

* Bot. Zeitung, 1871, Nos. 18 and 19.

† Das Inulin, Munich, 1870; and Bot. Zeitung, 1870, No. 39.

stem in the form of starch, and thus passes towards the buds. Subsequently the starch produced in the leaves descends along the stem in the form of starch itself or of sugar; and it is only on its arrival in the root that it takes on the form of inuline.

III.

We cannot conclude this revision of the principal recent physiological publications without casting a glance upon a group of very interesting works, although these do not yet allow us to rise to general conclusions. We would speak of fecundation in phanerogamous plants, and the part which insects perform in it. The idea itself is not new; and even a century ago Sprengel* cited numerous cases of flowers fecundated by the mediation of insects. But it is only in our time that it has been attempted to generalize these facts; and Mr. Darwin was the first to put forward the notion that the fecundation of a flower by itself is contrary to the laws of nature, and that the reproduction of a species is not well assured except by crossings between different individuals.

A theory like this cannot of course be proved except by direct investigation of facts; and the facts, when we have to do with fecundation, are most minute, and demand peculiarly ingenious and patient observations. Several naturalists have advanced to the breach; and we possess a fine collection of special memoirs, the conclusions from which already form a solid basis for theoretical ideas. However, if the observers have had to manifest great patience, the recompense waited for them at the end. Nothing is more curious than the details of organization by which spontaneous fecundation, apparently so easy, is rendered useless or even impossible. The researches of Mr. Darwin himself upon the fecundation of the Orchids, upon the dimorphism of the primrose, and upon the trimorphism of *Lythrum salicaria* are well known. He has found imitators in MM. Hildebrandt and Delpino. Both these authors have published numerous memoirs, sometimes studying thoroughly all the details of fecundation in a certain plant or family, sometimes tracing throughout the vegetable kingdom a certain type of fecundation, and pointing it out wherever it is manifested. M. Hildebrandt †, moreover, some time since, brought together all the data we possess upon the subject, and endeavoured to group them methodically. The perfectly uniform conclusion of all these works is, that in the great majority (if not in the totality) of plants direct and spontaneous fecundation is im-

* Das entdeckte Geheimniss der Natur im Bau und Befruchtung der Blumen. Berlin, 1793.

† Die Geschlechter-Vertheilung bei den Pflanzen. Leipzig, 1867.

possible, and that the intervention of insects is always necessary.

In a multitude of cases the expansion of the stigma does not take place at the same time as the opening of the stamens; the flowers are what are called "dichogamous," and may be protandric or protogynic.

The former are most frequent. Entire and most important families enter this category, such as the Labiatæ, the Scrophulariaceæ, the Compositæ, and the Campanulaceæ. Here the office of insects is very evidently necessary; and it is facilitated by the most varied details of organization. For example, in the whole of the immense group Compositæ* the five stamens have the anthers soldered into a cylinder, which envelopes the pistil; they open and allow the pollen to escape before the style has become elongated. The style bears, below the stigma, a certain number of rigid hairs, which retain the pollen-grains, and carry them forward with them in their ascending movement at the moment of the elongation of the style. The pollen thus carried up out of the cylinder of the anthers is collected by insects and transported to flowers the stigma of which is already expanded.

In the Campanulaceæ†, Lobeliaceæ, &c. the system is the same, only the appendages destined to retain the pollen on the style present a very variable form.

In the whole of the group of Scrophulariaceous Labiatæ‡ the axis of the flower is horizontal, and the stamens are approximated beneath the upper lip of the corolla. The insects, in passing, separate and jostle them, cause the pollen to fall from them, and then transport it to a more advanced flower. In certain genera the stamens alone stand in the way of the insect, which always seeks the bottom of the flower, where the nectaries are. Later on they curve outwards, the style in its turn becomes elongated, and advances to take their place, and its recurved extremity caresses the body of the insect loaded with pollen.

In certain plants in which the expansion of the reproductive organs is simultaneous, the part performed by insects is no less maintained. In their absence spontaneous fecundation, which nevertheless appears to be inevitable, does not take place, or produces very little effect. Such, for example, are numerous Leguminosæ§, in which the stamens and the pistil are enclosed in the keel, in very close proximity. Insects, going to collect

* "Ueber die Geschlechtsverhältnisse bei den Compositen," Acta Leop. Carol. vol. xxv. 1869, and Bot. Zeitung, 1870, No. 30.

† "Ulteriori osservazioni sulla dicogamia nel regno vegetale," Atti della Soc. Ital. di Sci. Nat. vols. xi. & xii.; and Bot. Zeitung, 1870, Nos. 37–42. ‡ *Ibid.* § *Ibid.*

the nectar, touch the back of the keel; the latter throws itself briskly backward; the insect receives a few grains of pollen, and transports them to the neighbouring flower. Without this intervention, often not a single seed is produced.

The family Fumariaceæ, lately studied by M. Hildebrandt*, presents us with a perfectly analogous example. The stamens and the pistil are narrowly enclosed between the two petals, and appear to be removed from all exterior action. But the base of the petals, which is produced into a spur, offers an abundant provision of nectar. To reach it the insect must pass between the two petals, the upper part of which, borne upon a sort of hinge, separates easily. It thus loads itself with pollen.

Lastly, some flowers are polymorphic. By this name we designate the species in which the stigma and the stamens, which are placed at different heights in the corolla, do not always occupy the same relative positions. In some individuals the stigma, borne upon a long pistil, passes the corolla more or less, whilst the stamens remain very short; in others the stamens advance and the pistil remains short.

Mr. Darwin† was the first to study this peculiarity in *Primula* and *Lythrum*. M. Hildebrandt has since observed a great number of polymorphic flowers. Better than any others they show the necessity of crossings. In fact a pistil is fertilized only by the stamens which are developed at the same height with itself relatively to the corolla, and consequently of necessity in another flower. Numbers in connexion with this subject are more eloquent than any thing else. In experimenting upon a trimorphic *Oxalis*, M. Hildebrandt‡ obtained the following results:—

28 flowers with long styles, fecundated with pollen from flowers with long stamens, produced 28 capsules, each containing on an average 11·9 fertile seeds.

23 flowers with long styles, fecundated with pollen from median stamens, produced 2 capsules, which, together, only furnished a single seed.

14 flowers with long styles, fecundated with pollen from short stamens, produced no capsule at all.

38 flowers with median styles, fecundated with pollen from median stamens, produced 38 capsules, containing on an average 11·3 seeds.

* "Bestäubungsvorrichtungen bei den Fumariaceen," Pringsheim's Jahrb. vii. p. 423.

† "Dimorphism in *Primula*," Linn. Soc. Journ. vi. 1862. "Hétéromorphisme et ses conséquences," Ann. Sci. Nat. 1863, tome xix.

‡ Bot. Zeitung, 1871, Nos. 26 and 27.

The other numbers correspond exactly with the preceding; but these suffice to enable us to appreciate what takes place.

It is likewise useless to prolong further the extracts from these works. What we have said is sufficient to show their general character, and the importance of the results already obtained.

We here terminate this rapid and necessarily imperfect revision. But the quantity of materials is considerable, the subjects treated are very varied, and it is very difficult to bring the whole within the limits of a single essay. We hope on another occasion to be able to complete what is deficient here.

XXV.—*On the Development of* Syngamus trachealis.

By Prof. Ehlers*.

I am indebted to the kindness of Baron von Freyburg, of Regensburg, for the opportunity of tracing experimentally the course of development of this worm, which is parasitic in the tracheæ of birds, and, when it occurs in quantity in aviaries, pheasantries, and poultry-yards, produces considerable losses by the destruction especially of young and weakly animals. The parasite was introduced with some exotic birds into the aviary of the Baron von Freyberg during the illness of its owner, and has since occurred there more or less abundantly. The birds attacked by the worm betray this generally at first by a peculiar cough, during which they frequently throw the head to and fro, and not unfrequently at the same time expel small masses, which they generally pick up and swallow immediately. Large birds bear the parasitism of the worm, if it does not occur in too large numbers, for a long time; small birds, on the contrary, often die suddenly—it would appear, especially by the pair of worms (which, as has long been known, reside in the trachea usually *in copulâ*) placing themselves in such a position that the passage of the air-tubes is stopped, and the birds are suffocated.

In a *Cardinalis virginianus* which M. von Freyberg gave me for examination, and which, according to him, had long been infested by *Syngamus*, I could see the animals in the entrance to the upper larynx, and take them out with a fine forceps. In freshly infected tits, the mucous membrane of the throat was more strongly reddened than usual, and exhibited some very fully charged superficial veins. But the most

* From the 'Sitzungsberichte der phys.-med. Societät zu Erlangen,' Dec. 5, 1871. Translated by W. S. Dallas, F.L.S., from a separate copy communicated by the Author.